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tion of the old law, $b \sin z$ for the R—D correction, virtually neutralising the flexure correction, would imply that the latter was erroneous. As regards the question of refraction, a comparison is given between the temperatures of the air at different altitudes as observed by Mr. Glaisher in his balloon ascents and those assumed by Laplace, Bessel and Lubbock in their theories of refraction; and the inference is drawn that Bessel's refractions may be too large for large zenith distances, through his assumption of an erroneous law for the constitution of the atmosphere, though they may be sensibly correct as far as about Z.D. 80°.

Description of a proposed new Uniform Pressure Clock. By T. Buckney, Esq.

The object of the present paper is to submit to the consideration of the Royal Astronomical Society a means of preventing the changes in the density of the atmosphere from reaching a clock and affecting its rate, by enclosing the clock in an air-tight case in which a uniform pressure may be maintained.

The late Mr. Carrington endeavoured to attain the same end by having a case of copper made for a clock of the ordinary construction; but he does not appear to have been entirely successful. The necessity of winding the clock with a winder passing through a stuffing-box seemed to be a source of frequent trouble, and the repeated breaking of the plate glass covering the dial was also an annoyance. I venture to think the method I am about to describe promises a better result.

I propose, in the first place, to mount the clock movement and hang the pendulum on a massive bracket projecting like a shelf from the wall to which it is fixed; covering both with a bell-glass like the receiver of an air-pump.

To the under side of the shelf I propose to fix a similar bell-glass, but one so elongated as to take in and enclose the pendulum. The upper and under surfaces of this shelf, which would form the seat-plate of the clock, would be worked to a true plane, and the bell-glass covering the movement would have a ground edge, so that the joint made here would be air-tight. It would probably be very difficult to grind the edge of the lower glass on account of its depth, therefore it would be better to fasten to it, by a suitable cement, a metal ring previously worked to a true surface, and thus obtain an equally good joint with the under side of the seat-plate. The space thus enclosed by these glass vessels would form the clock-case, and would be placed in connection with an air-pump by a tube screwed into the seat-plate. Now, setting aside for the moment the necessity of winding, and assuming the above provisions to be successfully carried out, we should have a clock going in an air-tight case in which the pressure may be

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reduced to and maintained at any desired point. A barometer tube and a thermometer placed in the case would enable the pressure and temperature to be readily seen.

I will now show how the clock may be kept wound without interfering with the state of things thus far produced. Almost all Observatory clocks, such as this would be, are provided with some means of making galvanic contact every second, this seconds' contact being used for the purpose of pricking on a chronograph barrel, working electric dials, or controlling other clocks—in fact, for distributing the time shown by the standard clock to other parts of the building. At the Royal Observatory, Greenwich, this is done through the agency of a "relay" which, itself worked by a feeble current sent through the clock-springs, sets in motion, simultaneously, three other distinct and more powerful currents, which convey the time to the distant instruments. I propose, therefore, that the clock we are considering shall, in like manner, make a seconds' contact, and work a similar relay: the wires connecting the relay with the clock springs passing through the seat-plate. Now, one of the currents emanating from the relay I propose to take back into the clock-case, and allot to it the task of winding the clock. This it would do by means of a small electro-magnet attracting, every time the current passed—that is, every second—an armature provided with a click which would act upon a ratchet wheel connected with the winding work. Thus the clock would not be an electric clock which any failure of the current would stop and render useless: it would be a clock actuated by a weight as usual; but this weight would be wound up every second by the current set in motion by the clock itself. It would be automatic, assuming the current to pass with regularity: but in the event of the current ceasing, the clock would continue to go until the weight had run down; and even then it might be wound from the outside by means of a hand "contact-breaker" introduced into the circuit which does the winding. But let us suppose that a failure has taken place in the current of the primary circuit, as we may call the one by which the relay is worked, that being the only one with which we need deal, seeing that any defect in the subsidiary ones could be remedied outside and independently of the clock; and let us consider what amount of inconvenience would be caused by any such failure. Now, setting aside as improbable such an accident as a severance or disconnection of the wires, a failure must, I conceive, arise from one of two causes: either the battery must have ceased to generate a current, in which case a new one would have to be substituted for it at no greater inconvenience than is experienced under existing circumstances; or there must be a stoppage of the current by the oxidation and fouling of the contact-springs, which would then require cleaning, for which purpose access to the clock must be had, and the uniformity of the pressure disturbed. But even from this no great harm would, I think, arise. It is assumed that the normal pressure in the clock-case would be but a little less than the lowest

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atmospheric pressure of the locality, so that the danger of leakage might be reduced to a minimum. To remove the contact-springs from the clock all that would be necessary would be to let in the air; lift off the upper bell-glass; pull out the slide on which the springs are mounted; do what might be found necessary in the way of cleaning; replace them in their position; put on the bell-glass cover again, and reduce the pressure to its normal point. As I have said, I cannot conceive that such an operation as this should necessarily cause any great or permanent disturbance in the clock's rate. But in any case the contact-springs would require cleaning only at long intervals. The great trouble with galvanic contacts has arisen from the fusing and oxidation of the platinum points by the spark of the induced current produced at the breaking of the circuit. A simple means of entirely preventing this spark is now known, and there is no longer this difficulty. I believe the galvanic contact-springs of the Greenwich Standard Sidereal Clock have been working with the greatest regularity for five months, and it has not yet been found necessary to clean them: what is done at Greenwich in this way may, it is obvious, be done elsewhere with equal success.

We will now return to the winding, which, it will be remembered, is to be done every second. Now, in order that this constant winding may in no way interfere with the good going of the clock, but that the force acting on the clock train may be constantly uniform, I propose to use the arrangement known as the "endless chain," although in this instance it would probably be an endless line of silk of uniform thickness, which I think would answer perfectly. Sufficient fall for the weight should be allowed for the clock to go for two days after a cessation of the winding.

In such a clock any desired pendulum or escapement may be used. The clock should be fixed in such a position that a uniform temperature should be maintained, if possible; and, in order to facilitate this, I would envelop the glass vessels in an outer casing of thick wood lined with felt or other non-conducting material. Unless the air were entirely removed from the clock case—a state of things very difficult to maintain for any length of time—it is evident that changes of temperature would produce corresponding changes of pressure: and although these could, no doubt, be easily corrected by a proper allowance for them in the thermal compensation of the pendulum, as are the other more important temperature effects, still it would, I imagine, be better to avoid these errors. In any case, sudden changes of temperature ought to be carefully guarded against: they do a certain amount of mischief before the compensation is brought into operation.

I may state in conclusion, in order to avoid the charge of appropriating to myself and taking credit for the inventions of others, that the "endless chain"—the earliest form of maintaining power—was invented by the Dutch philosopher Huyghens in

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the 17th century: and that the general plan of the air-tight case is almost identical with that used by Mr. Baily in his pendulum experiments; although I was not aware of this until quite recently. The method of winding is, I think, the only thing which is new: if, therefore, any merit attaches to the arrangement herein described, it is due rather to the aggregation of means conducing to the general result than to any special point of detail.

1880, *January*.

Notes on "A Catalogue of 10,300 *Multiple and Double Stars &c.," forming Vol. XL of the Memoirs of the Royal Astronomical Society.* By H. Sadler, Esq.

(Hours O–VI.)

No. for Reference.

2. This is 316. Cephei. (Bode.)

3. Σ^2(2) c.g. This star is not entered in the *Catalogus Generalis* as a double star, for Struve expressly states on the *first* page of that Catalogue: "Stellæ, quibus nullum adjectum est epitheton, ut 6. γ Pegasi, sunt stellæ vere simplices, quantum hucusque compertum est." It is one of the "Stellæ Primariæ," of which a catalogue is given on pp. xxxxviii to l of the Introduction (cf. also the *Summa Catalogi Generalis*, on p. lxxx). The only claim that it has to be considered in any way a *double* star is that it is S.C.C. 2, but no reference is made to this.

8. The N.P.D. should be 79° 31′, not 79° 36′.

14. Σ.6. Add *Rej.* Rejected from the great catalogue because, being of Class iv. in distance, the companion is under the ninth magnitude.

30. Cf. No. 3. The only reason for including it in a Catalogue of Double Stars is that it is S.C.C. 6.

42. OΣ 3. This is identical with No. 62, Σ 19, there being an error of 2^m in the A.R. of the Catalogue of 1843. Cf. page 297 of *Catalogue revu et corrigé*, in the *Recueil de Mémoires*, &c.

57. Σ 18. In a note on No. 90. *h* 1018, Sir J. Herschel observes: "The N.P.D., description, and measures agree well with those of Σ 18, but the R.A. differs by 4^m. Original observation examined. All perfectly regular and clearly entered. It can hardly be the same double star" (p. 132). Σ 18 *is h* 1018, there being an error of 4^m of R.A. and 2′ of Decl. in the Dorpat Catalogue. Cf. Σ. *P.M.*, pp. xc and cxv.

67. Σ 21. Add *Rej.* Rejected in the *Mensuræ Micrometricæ* because the primary is less than the ninth magnitude.

87. This is also σ 6.

93. Σ 26. Add *Rej.* Cf. No. 14.

120. Single, and therefore rejected in the Catalogue of 1850.

128. Single, and therefore rejected in the Catalogue of 1850.

130. The R.A. is 1^m in error; it should be $0^h\ 19^m\ 51^s$. Cf. *P.M.* "Notæ Criticæ," pp. xciii, cxii; also pp. 173 and 295 (reference on).

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